Traumatic Carotid-Cavernous Fistula: Endovascular Treatment with Onyx and Coils

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Summary

Carotid cavernous fistulas (CCF) are mostly post-traumatic and are due to a tear of the internal carotid artery (ICA) inside the cavernous sinus. The improvement of endovascular techniques with venous approach enables the preservation of internal carotid artery patency in most cases when detachable balloons fail in order to reconstruct and repair the tear in the ICA. The case described here has a giant aneurysmatic dilatation of the cavernous sinus and inferior petrosal sinus. We associate coils and Onyx to occlude the lesion preserving and repairing the large hole of the fistula.

Introduction

Direct carotid cavernous fistulas (CCF) are communications between the internal carotid artery and the cavernous sinus. They are mostly post-traumatic and due to laceration of the carotid siphon or rupture of its intracavernous branches occurring during abrupt deceleration in traffic accidents [1]. Direct penetrating trauma or intracavernous aneurysmal rupture are other less common causes.

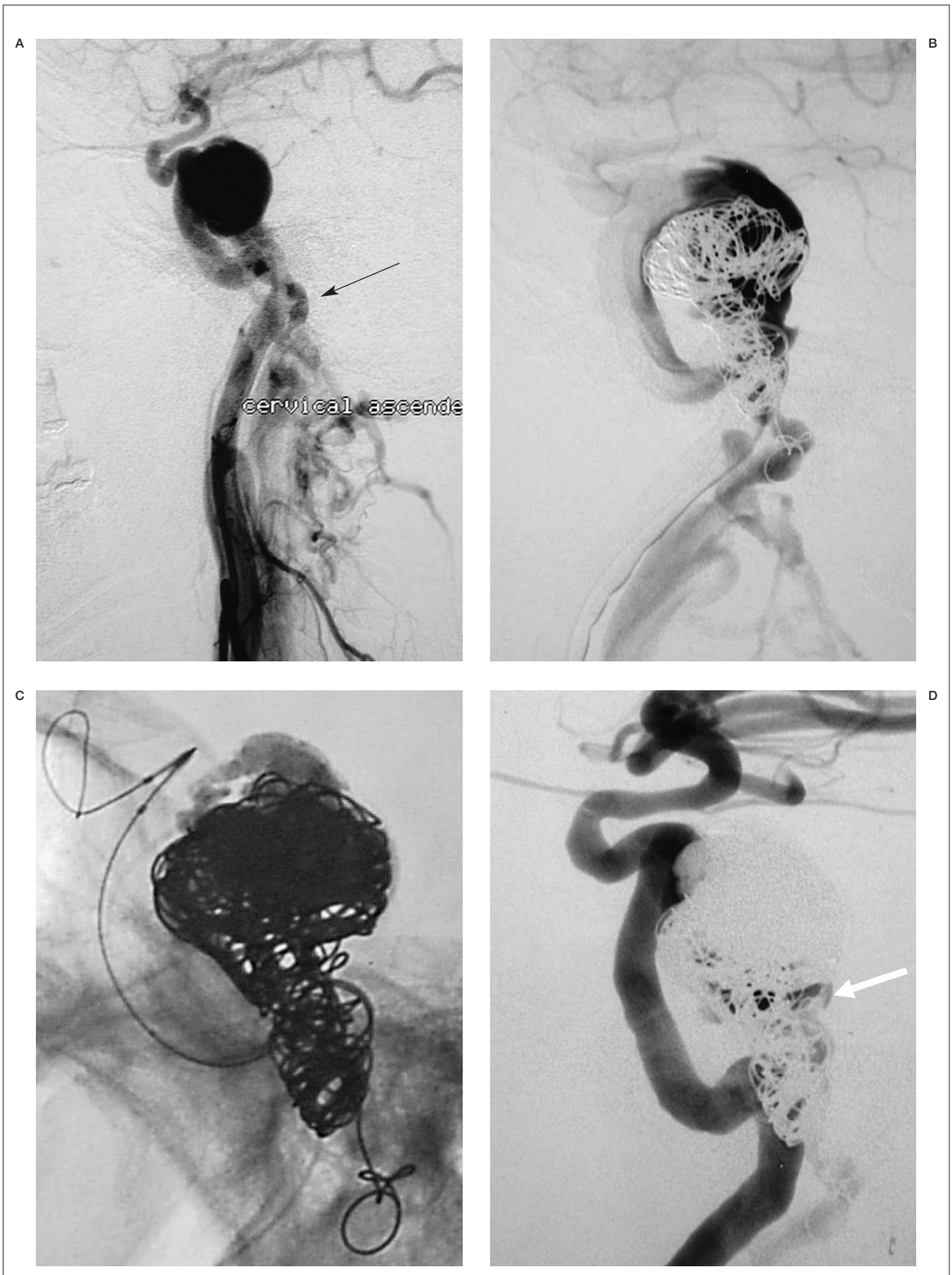
Clinical manifestations of traumatic carotid cavernous fistula (CCF) are well known in the literature, including angiographic features related to a poor clinical evolution like epistaxis, neurological deficit and intracranial bleeding [2-4].

Detachable balloons are the first option to occlude the fistula. Detachable coils are other devices used to treat CCF when detachable balloons fail to occlude the fistula preserving patency of the ICA and can be introduced by arterial or different venous approach [5-8].

In the case presented here, the CCF hole was large, the cavernous sinus very dilated, without trabeculae inside to support a balloon close to the fistula hole. Our strategy was occlude the lesion associating coils and Onyx in order to repair and preserve the ICA lumen. To our knowledge, this is the first study to report the use of Onyx- a new embolic agent (Micro Therapeutics Inc (MTI), Irvine, CA) – through an arterial route as a complementary tool in the treatment of a traumatic direct CCF.

Case Report

This 24-year-old man suffered a penetrating right orbit trauma with a radio antenna. After three weeks he developed right eye injection, chemosis and proptosis, peri-orbital swelling, diplopia and a bruit at the right ear. A CCF was diagnosed in November 1995 by an eye sonogram and confirmed by angiography. In December 1996 (eighteen months after the trauma) after worsening of the symptoms, surgical occlusion of the right common carotid artery was done by a neurosurgeon in another hospital with discrete and transitory improvement of symptoms.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In December 2002 (six years after surgery) symptoms became worse. Angiography showed persistence of the fistula. At this point he was referred to our hospital (clinical evaluation - table 1) and was submitted to a new angiography that showed filling of the right external carotid artery by anastomosis with the deep cervical artery. In addition, the right internal carotid artery was filled by the right external carotid artery with persistence of the CCF with a giant aneurysmatic dilatation of the right cavernous sinus extending through the inferior petrosal sinus with no other drainage of the fistula.

The endovascular treatment was performed under general anesthesia with endo-tracheal intubation in April 2003. A 4F sheath was placed in the right internal carotid artery by direct puncture and a 5F sheath was placed in the right femoral artery for angiogram control. The cavernous sinus was catheterized with a microcatheter (Rebar 14 – Micro Therapeutics Inc [MTI], Irvine, CA). Through the 4F sheath a total of ten Guglielmi detachable coils (GDC) – two GCD ®-18-standard 8 mm x 30 cm; one GCD ®-18-2D 8 mm x 30 cm; four GDC ®-18-standard 10 mm x 30 cm; three GDC ®-18-standard 5 mm x 20 cm – were deployed in the inferior part of the right cavernous sinus and superior part of the inferior petrosal sinus. Because there was still filling of the superior aspect of the cavernous sinus adjacent to the fistula and persistent flow through the coil mesh, a total of 4.5 ml of Onyx HD500 (liquid embolic agent – Micro Therapeutics Inc (MTI), Irvine, CA) was injected. The same technique used to treat aneurysms was adopted. The balloon (4 x 20 mm Hyperglide – Micro Therapeutics Inc (MTI), Irvine, CA) was inflated to cover the fistula, injecting Onyx for five minutes and then deflating the balloon for two minutes for brain perfusion and then a new cycle was started until the ICA tear was completely occluded. Eight Onyx injections were performed (figure 1), with a good reconstruction of the ICA at the level of the fistula, preserving the arterial lumen.

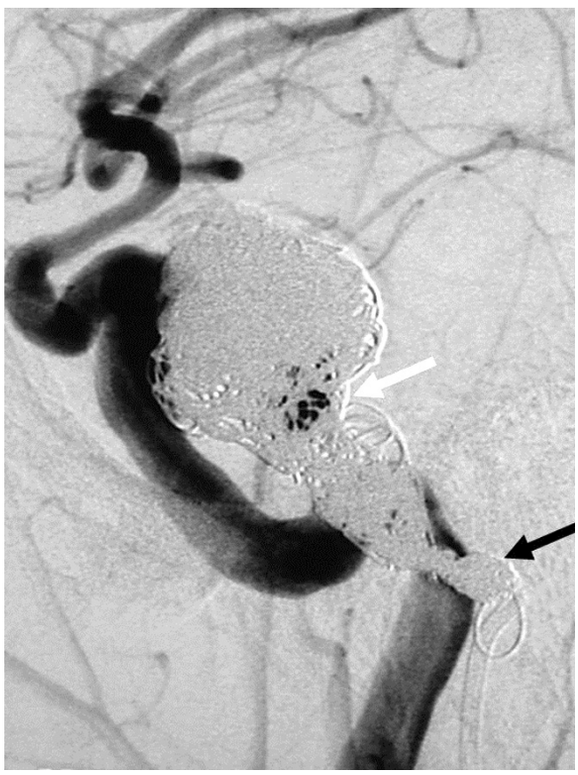

Figure 2 Right ICA control angiogram 3 days after the first treatment and after coil occlusion of the distal portion of the IPS by venous approach. There is still some filling inside the cavernous sinus (white arrow), but no more distal flow in the IPS (black arrow).

However, because there was not complete occlusion of the lesion and the fistula was still draining to the inferior petrosal sinus, a second procedure was performed three days later by venous approach. A 5F sheath was inserted into the femoral vein and a catheter was placed in the inferior petrous sinus. A total of six coils – Trufill ® DCS Detachable coil: one 10 mm x 30 cm complex; one 8 mm x 30 cm helical; one 4 mm x 10 cm helical; one GDC ®-10-standard 10 mm x 30 cm; one GDC ®-10-standard 7 mm x 30 cm; one GDC ®-10-soft 3 mm x 10 cm – were deployed with complete occlusion of the fistula outlet and the venous aneurysm (figure 2).

Some symptoms improved enormously (Table 1) and the patient was discharged without

Figure 1 A) Digital subtraction angiography of the right ascending cervical artery in the lateral view, showing recanalisation of the right ICA, good filling of the middle cerebral artery and the CCF with a giant aneurysmatic dilatation of the cavernous sinus and its venous drainage through the inferior petrousal sinus (black arrow). B) Right ICA angiogram after coil deployment showing persistence of flow and a large proximal residual part of the CS. C) Plain X-ray after Onyx deployment into the proximal part of the cavernous sinus. (D) Final control showing a good reconstruction of the ICA tear, but persistent flow through the embolic devices (arrow).

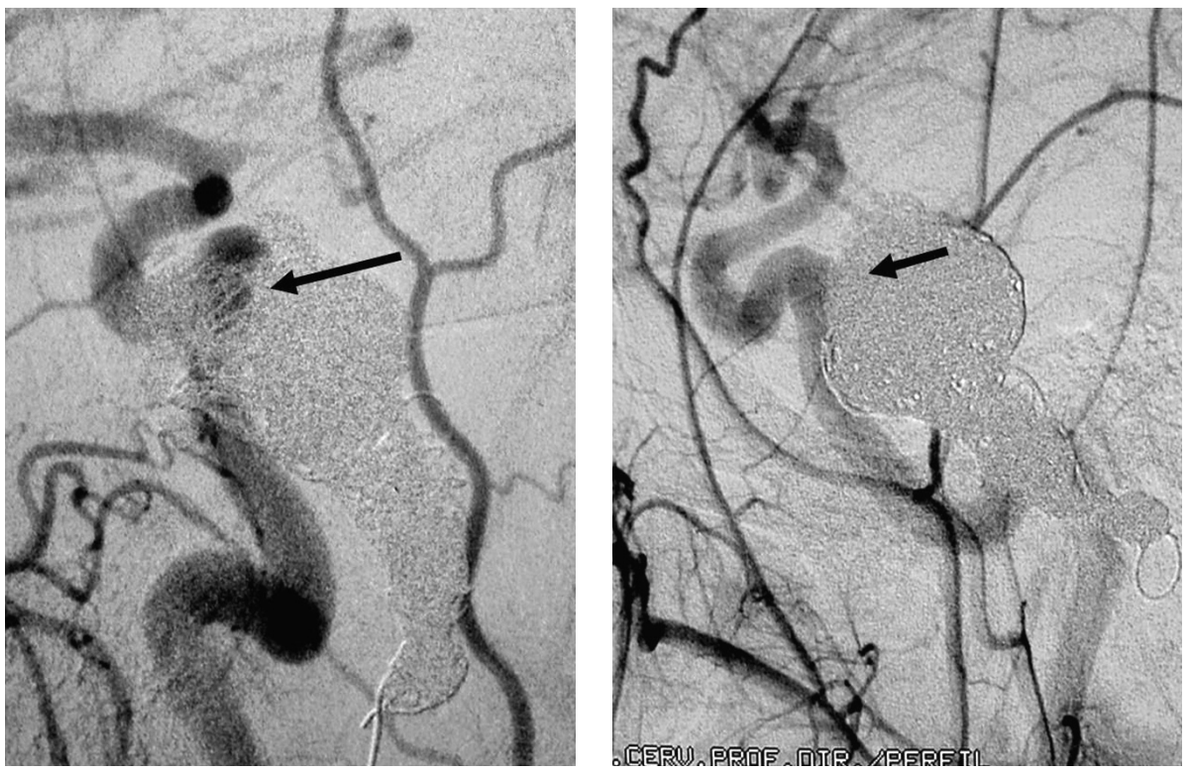

Figure 3 Right deep cervical artery angiogram seven months after treatment in oblique (A) and lateral view (B). Complete occlusion of the CCF and good remodeling of the ICA at the level of the fistula (arrow).

deficits after a few days. Seven months angiographic follow-up showed complete occlusion of the fistula and patency of the internal carotid artery (figure 3), with a complete reconstruction of the ICA. Clinical follow-up was done twenty months after endovascular treatment (Table 1).

Table 1 **Clinical follow-up after endovascular treatment of the carotid cavernous fistula.**

Symptom	Before endovascular treatment	20 months after endovascular treatment
Headache	+++	-
Diplopia	+++	+
Proptosis	++++	+
Chemosis	+++	+
Visual Acuity	normal	normal
Bruit	+++	-
Scotomas	+	+
Abnormal Ocular Movement	+++	+

Discussion

The treatment of traumatic CCF is an elective procedure unless there is an emergency situation such as progressive loss of vision, acute intracerebral haemorrhage, progressive neurological deficit, massive epistaxis, recruitment of cortical venous drainage, an intraocular pressure higher than 40 mm Hg [9] or "aneurysmatic" dilatation of the cavernous sinus.

In most cases, detachable balloon are the best way to treat CCF and are used as a first tool, trying to preserve the ICA lumen. Coils are another option, when it is not possible to preserve the arterial lumen with detachable balloons, and can be used by arterial or venous approach.

The giant pouch in the CS was a unique compartment without trabeculae inside and many detachable balloons were necessary to occlude

it. In this situation, the last balloon was very difficult to detach and due to the large tear in the ICA, this could have been impossible to do without occluding the artery. The ICA was the main source of supply to the middle cerebral artery (figure 1A), without steal phenomena by the fistula. The other problem for detachable balloon in this particular case was the probability to have a very large false aneurysm after deflation of the balloons, which can become symptomatic due to its size.

In our case, the cavernous sinus was very large due to the chronic high flow shunt, so we decided to use Onyx to preserve the arterial lumen and because it is cheaper compared to the number of coils necessary to occlude the entire lesion. Due to the high flow, Onyx could migrate to the venous outlet, then we first reduced the flow and made a mesh with coils to retain Onyx, allowing its injection without a migration risk. In some cases, NBCA can be used to finish the occlusion of the outlet of the fistula, after partial occlusion with coils. However, in this case (figure 1B) the NBCA injected distally in the IPS could have occluded the outlet but a large residual dilatation of the CS would persist. Injection of NBCA in the proximal portion of the CS had a high risk of migration into the ICA. More coils would have been necessary to occlude this portion. For these reasons, we decided to use Onyx, that is more controllable and produces a better repair of the tear.

After finishing the occlusion of the ICA tear, there was still flow through the fistula, probably because Onyx is not adhesive and allows permeation of blood throughout its spongy-like mass. Three days were waited but thrombosis of the fistula did not occur, so the lesion outlet was occluded with coils.

Onyx allowed a good and stable reconstruction of the artery tear without formation of a false aneurysm as we often see when detachable balloons are used after their spontaneous deflation. This is a good advantage of Onyx even if a residual late false aneurysm rarely gives symptoms or needs to be treated.

Conclusions

To our knowledge this is the first description of Onyx used through an arterial route to treat traumatic direct CCF. Its use is possible in association with coils to avoid migration of the liquid embolic material. Onyx is cheaper when a large number of coils is needed and allows a better reconstruction of the artery tear. Further control and more cases will answer questions about the stability of the arterial repair. Onyx seems a good option in cases where we have a large tear in the ICA and its lumen is difficult to preserve with other materials.

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